

A Review of Waste Management in the Antarctic



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Abstract

Effective waste management practices play an important part in reducing the environmental impact of human activities within the Antarctic region.

The formation of the Madrid Protocol has ensured that environmental management is treated with the same importance as peace and science in the continent. All operators are obliged to reduce the amount of waste produced or disposed of in Antarctica as much as possible.

The challenge of protecting the Antarctic in the future lies with the Treaty nations. The current acceptance of good waste management is a positive sign for the future but it is imperative that it is still recognised as an issue of high importance when the Treaty is reviewed or ends.



Photo 1: Abandoned fuel drums at Australian Wilkes Station

Introduction

Waste Management is an important global issue and is of particularly high importance in the fragile Antarctic environment. Despite the vastness of the continent, and its harsh climate, the Antarctic environment is very vulnerable to human impact.

All human activities result in some disturbance to the natural environment and produce waste. Effective waste management practices are an essential requirement for reducing the environmental impact of these activities. Due to its isolated geographical location, unique problems are presented when considering waste management in Antarctica.

Logistical factors such as accessibility of stations and camps, the nature of the terrain, severe environmental conditions, and the availability and capacity of transport need to be considered when implementing waste management plans. Additionally, the significant differences in operating conditions throughout the Antarctic region make it impractical to set a uniform approach to waste management.

This review investigates a number of themes relating to waste management in the Antarctic. It starts with an outline of the types of waste generated, followed by an investigation into how waste was managed historically. International waste management regulations are discussed, and an investigation into New Zealand's current waste management practices is made. The final section looks into the efforts being made to clean-up old waste disposal and abandoned work sites, as well as the future of waste management in the Antarctic.

Typical Wastes Generated in the Antarctic

The Scientific Committee on Antarctic Research (SCAR) refer to Antarctic waste as: *"waste which encompasses all domestic and operational waste generated during Antarctic operations and liable to be discharged or disposed of continuously or periodically, to the atmospheric, marine or terrestrial environments."*

The 'Antarctic operations' referred to in the above statement can be classified as follows:

1. Logistical Support
2. Science Programs (including field programs)
3. Station Operations
4. Construction and Maintenance Activities
5. Clean-Up Operations

A summary of the typical wastes generated by each of these operations is shown in Table 1:

Activity	Typical Wastes
Logistical Support	Waste lubricants and fuel, ferrous metal, aluminium, defective equipment and vehicles, wet-cell batteries, coolant water, shipboard wastes (sewage, laundry, galley wastes), empty fuel drums, exhaust emissions, wood, plastics, cardboard
Science Programs	Biological specimens, toxic/non-toxic laboratory chemicals, photographic and meteorological wastes, glycols and other flammable liquids, solvents, radioactive isotopes, gases, acids, alkalis,

	infectious/contaminated materials, rubber, glass, plastic, tin, paper, defective/obsolete equipment, building materials, food scraps, solid human waste, grey water
Station Operations	Glass, ferrous metal, aluminium, wood, plastic, paper, clothing and kit items, cardboard, kitchen and laundry effluent, expired/surplus stores, rotating biological contractor sediment, incineration ash (mainly from kitchen food scraps), rubber, dry-cell batteries
Construction & Maintenance Activities	Glass, ferrous and non-ferrous metal, wood, plastics, paper, cardboard, explosives, paints, concrete, old building components, fibreglass, cement and plasterboard sheeting, adhesives and sealants
Clean-Up Operations	Any of the above listed wastes, contaminated soils, fuel drums, rusted or corroded items, gas cylinders, animal carcasses

Table 1: Typical Waste Products Associated with Antarctic Operations

Waste generation in Antarctica varies significantly depending on the role, the level of activity, the season and the geographic situation of sites.

Wastes generated from logistical operations, science programs and station operations tend to be more constant and predictable, but construction and clean-up activities vary by season and station.

Coastal stations generate the most waste, especially stations which operate as transit stations for the resupply of inland sites and summer operations. The lowest waste production occurs at inland stations. The rates of waste production vary seasonally, with the highest rates in summer when major resupply and summer operations take place.

Historical Waste Management Practices

Although humans do not have a long history of interaction with Antarctica, human activities have irreversibly affected Antarctica and its surrounding seas.

Early expeditions, such as James Cook's circumnavigation of Antarctica in the late 18th century, discarded their waste by throwing it overboard. Although this is not a suitable practice today, it did not have a significant impact on the environment as the number of people involved and the amount of waste generated was relatively small. Additionally, the waste discarded was natural in origin (food, sewage, wood, fabric, metal etc.) so would have degraded to some extent.

Large numbers of sealers and whalers came to the Antarctic region in the early 19th century, leaving significant amounts of waste (building materials, food containers, metal pots) on numerous Antarctic and Sub-Antarctic Islands. After the last whalers left in the mid 1960s, whole whaling stations such as Grytviken and Leith Harbour on South Georgia were abandoned and left to ruin.

The major catalyst for human involvement in Antarctica was the International Geophysical Year (IGY) of 1957-58. This brought a number of additional waste-related issues.

Manufactured and synthetic products, like plastics, were introduced to Antarctica at this time. In the cold and dry Antarctic environment, synthetic materials like this will never degrade. Airplanes, vessels and vehicles, and the fossil fuels needed to run them, were also brought to Antarctica. These and other manufactured chemicals were often spilled, resulting in drastic effects on the environment.



An example of the effect of a spill is the case of the vessel Bahia Paraíso. The Argentine vessel hit an uncharted shoal off the Antarctic Peninsula in January 1989. The vessel carried around 250,000 gallons of petroleum products and during the course of the incident, the fuel spill spread to an estimated 6-mile radius. Much of the spilled fuel was dissipated by natural actions, but the wildlife population was significantly impacted.

Photo 2: Bahia Paraíso Incident

The increase of human activity following IGY resulted in an increase in waste released into the environment, including sewage and hazardous chemicals such as solvents and laboratory chemicals.



Permanent stations were also established, leading to garbage dumping and waste accumulation. Before permanent stations were established, waste was spread out as ships and ground-based expeditions disposed of their waste by leaving it wherever they were at the time. Once stations became permanently inhabited, waste accumulated in one spot. Although storms and wind would spread some of the waste across a wider area, most of it would remain localised.

Photo 3: Waste Accumulation

Waste was also released into the ocean. For many years, the U.S. program piled unwanted metal waste on the sea ice and waited for it to melt through or be carried away. Waste was also bulldozed into the sea near McMurdo Station and Scott Base. The sea floor in Winter Quarters Bay, around Hut Point, and at Pram Point on Ross Island is littered with large amounts of waste. It is easy to assume that this pattern of waste disposal has been repeated at many other stations around Antarctica and on the Antarctic and Sub-Antarctic islands.

International Waste Management Regulations

Following the establishment of the Antarctic Treaty in 1959, it was recognised that action needed to be taken to ensure the Antarctic region was not damaged by uncontrolled human exploitation.

The Antarctic Treaty nations took action accordingly and in 1991, the governing nations of Antarctica signed the Protocol on Environmental Protection to the Antarctic Treaty (the Madrid Protocol). In signing this, the Treaty parties declared Antarctica to be “*a natural reserve devoted to peace and science*”, and committed themselves to the “*...protection of the Antarctic environment and its dependent and associated ecosystems, and the intrinsic value of Antarctica, including its wilderness and aesthetic values...*”. The Protocol came into force in January 1998.

The provisions of the Protocol assemble and revise all existing environmental regulations under the Treaty, and establish new rules applying to all human activities in the Antarctic. Specific environmental rules are set out in a series of six practical annexes attached to the Protocol.

Annex III (refer Appendix I) sets out requirements for waste management in the Antarctic Treaty area. These requirements apply to scientific research programs, tourism and all other governmental and non-governmental activities. In summary, Annex III outlines the following requirements:

- Waste minimisation through source reduction and recycling;
- Activities planning must take waste storage, disposal and removal into consideration;
- Wastes removed from Antarctica must be returned to the country from which the activities generating the waste were organised;
- Past and present waste disposal sites, including abandoned work sites, are to be cleaned up;
- Materials, such as polychlorinated biphenyls (PCBs), non-sterile soil, polystyrene beads used in packaging, and pesticides (apart from approved scientific or hygienic purposes) are prohibited;
- Materials, such as radio-active materials, electrical batteries, excess fuels and containers, rubber, lubricating oils and plastics, must be removed from Antarctica by the generator of such wastes;
- Combustible wastes not removed must be incinerated in ways that reduce harmful emissions. Open burning of rubbish is banned (since 1999);
- Sewage and domestic liquid wastes must not be disposed of on sea ice or ice shelves, but may be discharged directly into the sea where conditions exist for rapid dispersal;
- Waste management plans, supervised by a designated officer, are required for all scientific stations and work sites;
- All Antarctic Treaty nations are required to exchange information on waste management practices, including disposal methods and approximate quantities of waste produced.

At sea in Antarctic waters, the disposal of waste is governed by the Marine Pollution Annex (**Annex IV**) of the Protocol (refer to Appendix II). Annex IV prohibits the discharge of all toxic and noxious chemicals, oil and oily wastes, plastics and other forms of non-biodegradable rubbish into the sea, and strictly controls the discharges of other wastes.

New Zealand's Waste Management Practices

New Zealand's approach to waste management in Antarctica has developed in the context of national and international obligations arising from the Antarctic Treaty system, specifically the Protocol on Environmental Protection to the Antarctic Treaty. The Protocol is enforced in New Zealand legislation through the Antarctica (Environmental Protection) Act 1994.

Antarctica New Zealand has developed a Waste Management Policy (refer Appendix III), where the overall policy statement is: *"Antarctica New Zealand will minimise, reduce and recycle waste generated by its activities as far as practicable and will ensure that waste is disposed of with minimal environmental impacts. Waste management planning will examine the use, where appropriate, of alternative technologies, materials and disposal options, and identify areas of past activity which require clean up and/or remediation."*

The Antarctica NZ Environmental Manager is responsible for developing, implementing and monitoring the Policy, and Antarctica NZ staff are trained in environmental and waste management procedures. At Scott Base, the Scott Base Manager is responsible for implementing the Policy.

The sections below outline the waste management practices in use by New Zealand Antarctic personnel.

Waste Minimisation

Waste minimisation has both environmental and financial benefits (approximately NZ\$10,000/year is spent on bringing Antarctic waste back to New Zealand and disposing of it). Minimisation is achieved through the following reduction, reuse and recycling practices:

- Unnecessary packaging and wastes are disposed of prior to travel to Antarctica;
- Reusable packing materials like bubble wrap and paper are used where possible. Vermiculite is only used to package hazardous liquids;
- Reuse practices such as double-sided photocopying and using worn out clothing as rags are adopted in Scott Base work areas;
- Recyclables are separated for recycling back in Christchurch.

Prohibited Products

The following products are prohibited in Antarctica:

- Polychlorinated biphenyls (PCBs)
- Non-sterile soil
- Polystyrene beads and chips
- Pesticides (unless required for scientific, medical or hygiene purposes)

Environmental authorisation is required for the following items:

- Radionuclides;
- Any non-native species of animal or plant (including seeds);
- Any non-native microorganism (including viruses, bacteria, parasites, fungi and yeasts)

Managing Wastes Generated in Antarctica

All visitors to Antarctica must separate the waste they produce and dispose of it according to the specific procedures set out in the Waste Management policy.

Waste is separated into four categories:

- a) Recyclables
- b) Hazardous and Biohazardous Waste
- c) General Waste
- d) Domestic Liquid Waste

a) Recyclables

Scrap metal, metal and aluminium cans, corrugated cardboard, newsprint and office paper and most glass generated at Scott Base and in the field are returned to New Zealand for recycling.

At Scott Base, collection points for recyclable waste are located close to where the recyclables are generated, for example, a can crusher is stored in the bar and offices have boxes for office paper.

In the field, double green rubbish bags are used for all recyclable waste. The recyclables are separated and taken to the correct collection point on return to base.

b) Hazardous and Biohazardous Waste

Hazardous wastes include fuel and oil products, oil spill wastes (e.g. soil, water and absorbents), antifreeze, coolant, contaminated water, batteries, asbestos, aerosols, explosives, paint products, compressed gas cylinders, detergents, disinfectant and glue, photochemicals, mercury, radioactive wastes and laboratory chemicals.

All hazardous waste, produced at Scott Base and in the field, is returned to New Zealand either by air or ship, where it is disposed of. A 'Shipper's Declaration for Dangerous Goods' form must be raised for all hazardous items transported by air or sea and the United States Hazardous Team must inspect and certify the cargo.

Table 2 outlines the transportation requirements for sending hazardous wastes back to New Zealand:

Hazardous Product	Packing and Transportation Requirements
Oil Products (JP8, mogas, kerosene, engine oil, lubricants)	Waste stored in separately labelled drums, then strapped together on a pallet and placed in a shipping container.
Oily Rags	Packed in labelled overpack drum.
Used Oil Filters	Packed in labelled overpack drum.
Soil or Water Contaminated with Oil	Packed in labelled overpack drum.
Antifreeze	Packed in labelled overpack drum.
Lead Acid Batteries	Batteries drained, packed in labelled plastic battery dispatch box for transport by ship.
Dry Cell Batteries	Packed into labelled plastic battery dispatch box.
Lithium Batteries	Battery terminals taped, packed into labelled plastic battery dispatch box.
Asbestos	Double-bagged in labelled heavy duty bags. Wastes too large

	for bagging are wrapped on plastic sheeting and sealed. <i>The Antarctica NZ Asbestos Policy must be followed when working with asbestos.</i>
Aerosols	Compacted into bales, labelled and loaded into Shipping Container designated for general waste.
Explosives	NOT returned to NZ unless they are accompanying a science event and are returned on the same year of transport to the Antarctic. Surplus explosives should be destroyed in a suitable location.
Paint Products	Paint products left in original cans and labelled appropriately. Empty paint product tins left to dry, flattened and treated as recyclable metal waste.
Detergents, disinfectants and glue	Left in original containers and labelled appropriately. Empty plastic bottles washed and treated. Empty glue tins are left to dry, flattened and treated as recyclable metal waste.
Compressed Gas Cylinders	Vented, if necessary. Dry powder extinguishers dismantled and nitrogen gas cartridge removed. Loaded into shipping container designated for general waste and labelled appropriately.
Photochemicals	Stored in labelled containers.
Mercury	NOT transported by air, only by ship at end of season. Waste thermometers returned complete.
Radioactive Wastes	Packaged in the same manner it was transported from NZ.
Vermiculite	Used where possible for repackaging hazardous chemicals and waste for return to NZ. If not reused, packed in lined triwall.
Other Chemicals	Returned in original containers. Tops securely fastened and sealed with plastic packing tape.
Breakables (non-recyclable glass and any other items which break into sharp pieces in transit)	Packed in labelled overpack drum. Fluorescent tubes and lamps packed together in a separate labelled box and packed into a drywall.

Table 2: Hazardous Product Transportation Requirements

Biohazardous wastes include all food, food contaminated waste, sanitary waste, medical waste and human waste from the field.

All biohazardous waste, generated at Scott Base and in the field, is returned to New Zealand by ship in sealed receptacles packed together in a designated shipping container. Biohazardous waste is sterilised on arrival in New Zealand.

Table 3 outlines the collection practices for biohazardous wastes at Scott Base and in the field:

Biohazardous Product	Collection at Scott Base	Collection in the Field
Food Waste (food scraps and liquids)	Collected in kitchen bins lined with two blue bags, then placed in kitchen landing box when full, ready for loading onto shipping container.	Collected in double blue bags (can be mixed with compactable items)
Food Contaminated Waste (packaging, serviettes etc.)	Collected in the Mess and Engineering and Administration Offices in blue bag lined bins, then compacted into bales,	Collected in double blue bags (can be mixed with compactable items)

	ready for loading onto shipping container.	
Medical Waste (used medical materials and medical sharps)	<p>Non-sharp materials collected in yellow biohazard bag in first aid room, then placed in plastic lined box in waste handling shed. When full, box is strapped, labelled and put in shipping container.</p> <p>Sharp materials collected in sharps container in first aid room, then moved to waste handling shed (as for non-sharp materials).</p>	-
Sanitary Waste (sanitary pads, tampons and condoms)	<p>Pads and tampons placed in marked bins in women's toilet cubicles. Condoms disposed of in sanitary bins or biohazards bag in first aid room.</p> <p>Bin contents then moved into yellow biohazard bags which are placed in the appropriate box in the waste handling shed.</p>	Pads and tampons collected in solid human waste bucket.
Laboratory Biological Waste	Collected in yellow biohazard bag in wet lab, then moved to appropriate box in waste handling shed when full.	-
Human Field Waste (urine, faeces generated away from Scott Base)	-	<p>Solid human waste collected in 20L clip-top container. Urine and grey water collected in 25L screw-top containers. Buckets returned to Scott Base and stored for return to NZ.</p> <p><i>Exceptions:</i></p> <ul style="list-style-type: none"> - For field parties working on or adjacent to the sea, sieved grey water and human waste can be discharged unmacerated to the sea or seashore below the high water mark, and; - On snow and ice, strained grey water and human waste may be discharged unmacerated to an ice pit or crack (only when transport limitations prevent removal of wastes to Scott Base).

Table 3: Biohazardous Collection Practices

c) General Waste

General waste includes non-recyclable, non-hazardous solid wastes such as paper, plastic, fabric and timber.

At Scott Base, compactable items such as non-recyclable paper and plastic are disposed of in general rubbish bags situated around the base. The waste is then collected, compacted into bales, and loaded onto shipping containers.

In the field, general waste is collected in double black bags. On return to base, the waste is separated, labelled and deposited in the correct place.

d) Domestic Liquid Waste

Domestic liquid waste includes grey water (domestic waste water), final rinse photographic water, waste hydroponics water and human waste from the Scott Base sewage system. Scott Base produces about 17,000L of waste water per day.



Photo 4: Scott Base Plant

Grey water, final rinse photographic water and human waste are treated in the Scott Base waste water treatment plant. The plant was commissioned over the 2001/2002 summer season and treats waste water using a biological process in conjunction with screening, clarifying and disinfecting processes. Following treatment, the waste water is discharged into the sea at Pram Point.

When the Scott Base hydroponics unit is operational, the waste hydroponics water is disposed of in a sink within the base buildings.

Clean-up Operations

The introduction of the Protocol on Environmental Protection to the Antarctic Treaty has ensured that waste disposal into the Antarctic environment is minimised, however pre-1980s waste disposal methods, such as rubbish dumps, water dumping and open burning, have left a number of polluted sites in the Antarctic.

The Protocol requires that past and present waste disposal sites on land and abandoned work sites be cleaned up by the generator of such wastes and the user of such sites, unless doing so caused more environmental damage or would impact a designated Historic Site or Monument.

In accordance with these obligations, New Zealand has carried out clean-up activities at Vanda Station, Cape Roberts and Cape Hallett (in conjunction with the United States Antarctic Program).

Other Treaty nations are also cleaning up their abandoned sites.



Photo 5: Tip at Casey Station

The Australian Antarctic Division (AAD) have cleaned up the land waste at Mawson station, and a clean-up of the Thala Valley tip site at Casey station is in progress. This tip clean-up will help develop techniques for site assessment, contaminant containment, monitoring and remediation which can then be applied to the clean-up of the larger tip sites at Wilkes station, abandoned in 1969.

The United Kingdom have so far spent £2m on removing abandoned British bases and waste dumps in Antarctica. The British Antarctic Survey (BAS) have removed redundant facilities at Signy Research station, the waste dump at Fossil Bluff summer field station, and the three remaining abandoned bases along the Antarctic peninsula (Danco Island, Prospect Point, Deception Island). Future clean-up work for BAS will focus on the facilities at South Georgia, Bird Island, Cape Geddes and Halley V.

Future Waste Management

The increase of human activity in the Antarctic is a growing concern from a waste management perspective. Up to 10,000 scientists and support staff now work in Antarctica each summer and the number of tourists visiting the continent is rising rapidly, with approximately 22,300 visitors during the 2004/05 season. As visitor numbers rise, it is essential that the waste management processes are regularly monitored and revised. The garbage dumps and waste disposal methods used thirty years ago were acceptable waste management processes at the time. Today, the same practices are no longer suitable.

Technical developments should be continually monitored to allow for the introduction of improved waste disposal technologies. One recent invention is the 'Rocket Toilet', a toilet containing a propane powered heater which fires up the waste until it disintegrates. Technological advances in the efficiency of existing energy systems and the use of renewable energy sources will also help minimise pollution and oil-spills in the Antarctic.

It is extremely important that human activities continue to be carefully regulated and controlled by the Antarctic Treaty and the Madrid Protocol. Scientists have considered disposing of nuclear wastes in Antarctica because it offers such advantages as lack of population in the polar regions, and stability and thickness of polar ice. The waste containers would be placed on the ice sheet surface or in a shallow hole and the heat from the waste would cause the containers to melt to the bottom of the ice sheet. The Antarctic Treaty prohibits the disposal of radioactive waste on the Antarctic continent so currently nuclear waste disposal is not possible. It is imperative that waste management in the Antarctic is still recognised as an issue of high importance when the Treaty is reviewed or ends.

While good management can limit the environmental impact of wastes, it is not possible to limit it entirely. Waste minimisation is the key to the future. Waste avoidance, reduction, reuse and recycling should be emphasised as the preferred approach ahead of waste treatment and disposal.

Conclusion

All human activities within the Antarctic affect the natural environment and produce waste. Effective waste management practices play an important part in reducing the environmental impact of these activities.

During the last decade, Antarctic Treaty nations have placed increasing emphasis on the environmental management of their activities in the Antarctic. The formation of the Protocol on Environment Protection to the Antarctic Treaty has ensured that environmental management is treated with the same importance as peace and science in the continent.

The Waste Disposal Annex (Annex III) of the Protocol obliges all operators to reduce the amount of waste produced or disposed of in Antarctica as much as possible. Waste storage, removal, disposal and audit, as well as recycling and source reduction, must be incorporated into the planning and conduct of all activities. Old waste disposal sites and abandoned work sites are also gradually being cleaned-up by the generators of the wastes.

In conclusion, it will be a challenge to protect the environment of Antarctica in the face of an ever-increasing human presence and mounting pressure for the use of its resources. However, the Protocol has changed the mentality of the Antarctic Treaty nations. The acceptance of good waste management in the conduct of all operations is a positive sign for the future.

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Appendix I

Annex III to the Protocol on Environmental Protection to the Antarctic Treaty

Waste Disposal and Waste Management

Article 1

General Obligations

1 This Annex shall apply to activities undertaken in the Antarctic Treaty area pursuant to scientific research programs, tourism and all other governmental and non-governmental activities in the Antarctic Treaty area for which advance notice is required under Article VII (5) of the Antarctic Treaty, including associated logistic support activities.

2 The amount of wastes produced or disposed of in the Antarctic Treaty area shall be reduced as far as practicable so as to minimise impact on the Antarctic environment and to minimise interference with the natural values of Antarctica, with scientific research and with other uses of Antarctica which are consistent with the Antarctic Treaty.

3 Waste storage, disposal and removal from the Antarctic Treaty area, as well as recycling and source reduction, shall be essential considerations in the planning and conduct of activities in the Antarctic Treaty area.

4 Wastes removed from the Antarctic Treaty area shall, to the maximum extent practicable, be returned to the country from which the activities generating the waste were organised or to any other country in which arrangements have been made for the disposal of such wastes in accordance with relevant international agreements.

5 Past and present waste disposal sites on land and abandoned work sites of Antarctic activities shall be cleaned up by the generator of such wastes and the user of such sites. This obligation shall not be interpreted as requiring:

- (a) the removal of any structure designated as a historic site or monument; or
- (b) the removal of any structure or waste material in circumstances where the removal by any practical option would result in greater adverse environmental impact than leaving the structure or waste material in its existing location.

Article 2

Waste Disposal by Removal from the Antarctic Treaty Area

1 The following wastes, if generated after entry into force of this Annex, shall be removed from the Antarctic Treaty area by the generator of such wastes:

- (a) radio-active materials;

- (b) electrical batteries;
- (c) fuel, both liquid and solid;
- (d) wastes containing harmful levels of heavy metals or acutely toxic or harmful persistent compounds;
- (e) poly-vinyl chloride (PVC), polyurethane foam, polystyrene foam, rubber and lubricating oils, treated timbers and other products which contain additives that could produce harmful emissions if incinerated;
- (f) all other plastic wastes, except low density polyethylene containers (such as bags for storing wastes), provided that such containers shall be incinerated in accordance with Article 3 (1);
- (g) fuel drums; and
- (h) other solid, non-combustible wastes;

provided that the obligation to remove drums and solid non-combustible wastes contained in subparagraphs (g) and (h) above shall not apply in circumstances where the removal of such wastes by any practical option would result in greater adverse environmental impact than leaving them in their existing locations.

2 Liquid wastes which are not covered by paragraph 1 above and sewage and domestic liquid wastes, shall, to the maximum extent practicable, be removed from the Antarctic Treaty area by the generator of such wastes.

3 The following wastes shall be removed from the Antarctic Treaty area by the generator of such wastes, unless incinerated, autoclaved or otherwise treated to be made sterile:

- (a) residues of carcasses of imported animals;
- (b) laboratory culture of micro-organisms and plant pathogens; and
- (c) introduced avian products.

Article 3

Waste Disposal by Incineration

1 Subject to paragraph 2 below, combustible wastes, other than those referred to in Article 2 (1), which are not removed from the Antarctic Treaty area shall be burnt in incinerators which to the maximum extent practicable reduce harmful emissions. Any emission standards and equipment guidelines which may be recommended by, inter alia, the Committee and the Scientific Committee on Antarctic Research shall be taken into account. The solid residue of such incineration shall be removed from the Antarctic Treaty area.

2 All open burning of wastes shall be phased out as soon as practicable, but no later than the end of the 1998/1999 season. Pending the completion of such phase-out, when it is necessary to dispose of wastes by open burning, allowance shall be made for the wind direction and speed and the type of wastes to be burnt to limit particulate deposition and to avoid such deposition over areas of special biological, scientific, historic, aesthetic or wilderness significance including, in particular, areas accorded protection under the Antarctic Treaty.

Article 4

Other Waste Disposal on Land

1 Wastes not removed or disposed of in accordance with Articles 2 and 3 shall not be disposed of onto ice-free areas or into fresh water systems.

2 Sewage, domestic liquid wastes and other liquid wastes not removed from the Antarctic Treaty area in accordance with Article 2, shall, to the maximum extent practicable, not be disposed of onto sea ice, ice shelves or the grounded ice-sheet, provided that such wastes which are generated by stations located inland on ice shelves or on the grounded ice-sheet may be disposed of in deep ice pits where such disposal is the only practicable option. Such pits shall not be located on known ice-flow lines which terminate at ice-free areas or in areas of high ablation.

3 Wastes generated at field camps shall, to the maximum extent practicable, be removed by the generator of such wastes to supporting stations or ships for disposal in accordance with this Annex.

Article 5

Disposal of Waste in the Sea

1 Sewage and domestic liquid wastes may be discharged directly into the sea, taking into account the assimilative capacity of the receiving marine environment and provided that:

(a) such discharge is located, wherever practicable, where conditions exist for initial dilution and rapid dispersal; and

(b) large quantities of such wastes (generated in a station where the average weekly occupancy over the austral summer is approximately 30 individuals or more) shall be treated at least by maceration.

2 The by-product of sewage treatment by the Rotary Biological Contactor process or similar processes may be disposed of into the sea provided that such disposal does not adversely affect the local environment, and provided also that any such disposal at sea shall be in accordance with Annex IV to the Protocol.

Article 6

Storage of Waste

All wastes to be removed from the Antarctic Treaty area, or otherwise disposed of, shall be stored in such a way as to prevent their dispersal into the environment.

Article 7

Prohibited Products

No polychlorinated biphenyls (PCBs), non-sterile soil, polystyrene beads, chips or similar forms of packaging, or pesticides (other than those required for scientific, medical or hygiene purposes) shall be introduced onto land or ice shelves or into water in the Antarctic Treaty area.

Article 8

Waste Management Planning

1 Each Party which itself conducts activities in the Antarctic Treaty area shall, in respect of those activities, establish a waste disposal classification system as a basis for recording wastes and to facilitate studies aimed at evaluating the environmental impacts of scientific activity and associated logistic support. To that end, wastes produced shall be classified as:

- (a) sewage and domestic liquid wastes (Group 1);
- (b) other liquid wastes and chemicals, including fuels and lubricants (Group 2);
- (c) solids to be combusted (Group 3);
- (d) other solid wastes (Group 4); and
- (e) radioactive material (Group 5).

2 In order to reduce further the impact of waste on the Antarctic environment, each such Party shall prepare and annually review and update its waste management plans (including waste reduction, storage and disposal), specifying for each fixed site, for field camps generally, and for each ship (other than small boats that are part of the operations of fixed sites or of ships and taking into account existing management plans for ships):

- (a) programs for cleaning up existing waste disposal sites and abandoned work sites;
- (b) current and planned waste management arrangements, including final disposal;
- (c) current and planned arrangements for analysing the environmental effects of waste and waste management; and

(d) other efforts to minimise any environmental effects of wastes and waste management.

3 Each such Party shall, as far as is practicable, also prepare an inventory of locations of past activities (such as traverses, field depots, field bases, crashed aircraft) before the information is lost, so that such locations can be taken into account in planning future scientific programs (such as snow chemistry, pollutants in lichens or ice core drilling).

Article 9

Circulation and Review of Waste Management Plans

1 The waste management plans prepared in accordance with Article 8, reports on their implementation, and the inventories referred to in Article 8 (3), shall be included in the annual exchanges of information in accordance with Articles III and VII of the Antarctic Treaty and related Recommendations under Article IX of the Antarctic Treaty.

2 Each Party shall send copies of its waste management plans, and reports on their implementation and review, to the Committee.

3 The Committee may review waste management plans and reports thereon and may offer comments, including suggestions for minimising impacts and modifications and improvement to the plans, for the consideration of the Parties.

4 The Parties may exchange information and provide advice on, inter alia, available low waste technologies, reconversion of existing installations, special requirements for effluents, and appropriate disposal and discharge methods.

Article 10

Management Plans

Each Party shall:

(a) designate a waste management official to develop and monitor waste management plans; in the field, this responsibility shall be delegated to an appropriate person at each site;

(b) ensure that members of its expeditions receive training designed to limit the impact of its operations on the Antarctic environment and to inform them of requirements of this Annex; and

(c) discourage the use of poly-vinyl chloride (PVC) products and ensure that its expeditions to the Antarctic Treaty are advised of any PVC products they may introduce into that area in order that these products may be removed subsequently in accordance with this Annex.

Article 11

Review

This Annex shall be subject to regular review in order to ensure that it is updated to reflect improvement in waste disposal technology and procedures and to ensure thereby maximum protection of the Antarctic environment.

Article 12

Cases of Emergency

1. This Annex shall not apply in cases of emergency relating to the safety of human life or of ships, aircraft or equipment and facilities of high value or the protection of the environment.
2. Notice of activities undertaken in cases of emergency shall be circulated immediately to all Parties and to the Committee.

Article 13

Amendment or Modification

1. This Annex may be amended or modified by a measure adopted in accordance with Article IX (1) of the Antarctic Treaty. Unless the measure specifies otherwise, the amendment or modification shall be deemed to have been approved, and shall become effective, one year after the close of the Antarctic Treaty Consultative Meeting at which it was adopted, unless one or more of the Antarctic Treaty Consultative Parties notifies the Depositary, within that time period, that it wishes an extension of that period or that it is unable to approve the amendment.
2. Any amendment or modification of this Annex which becomes effective in accordance with paragraph 1 above shall thereafter become effective as to any other Party when notice of approval by it has been received by the Depositary.

Waste Management Planning

1 Each Party which itself conducts activities in the Antarctic Treaty area shall, in respect of those activities, establish a waste disposal classification system as a basis for recording wastes and to facilitate studies aimed at evaluating the environmental impacts of scientific activity and associated logistic support. To that end, wastes produced shall be classified as:

- (a) sewage and domestic liquid wastes (Group 1);
- (b) other liquid wastes and chemicals, including fuels and lubricants (Group 2);
- (c) solids to be combusted (Group 3);
- (d) other solid wastes (Group 4); and
- (e) radioactive material (Group 5).

2 In order to reduce further the impact of waste on the Antarctic environment, each such Party shall prepare and annually review and update its waste management plans (including waste reduction, storage and disposal), specifying for each fixed site, for field camps generally, and for each ship (other than small boats that are part of the operations of fixed sites or of ships and taking into account existing management plans for ships):

- (a) programs for cleaning up existing waste disposal sites and abandoned work sites;
- (b) current and planned waste management arrangements, including final disposal;
- (c) current and planned arrangements for analysing the environmental effects of waste and waste management; and
- (d) other efforts to minimise any environmental effects of wastes and waste management.

3 Each such Party shall, as far as is practicable, also prepare an inventory of locations of past activities (such as traverses, field depots, field bases, crashed aircraft) before the information is lost, so that such locations can be taken into account in planning future scientific programs (such as snow chemistry, pollutants in lichens or ice core drilling).

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2. Each Party shall send copies of its waste management plans, and reports on their implementation and review, to the Committee.
3. The Committee may review waste management plans and reports thereon and may offer comments, including suggestions for minimising impacts and modifications and improvement to the plans, for the consideration of the Parties.
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(c) discourage the use of poly-vinyl chloride (PVC) products and ensure that its expeditions to the Antarctic Treaty are advised of any PVC products they may introduce into that area in order that these products may be removed subsequently in accordance with this Annex.

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Appendix II

Annex IV to the Protocol on Environmental Protection to the Antarctic Treaty

Prevention of Marine Pollution

Article 1

Definitions

For the purpose of this Annex:

- (a) "discharge" means any release howsoever caused from a ship and includes any escape, disposal, spilling, leaking, pumping, emitting or emptying;
- (b) "garbage" means all kinds of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship, except those substances which are covered by Articles 3 and 4;
- (c) "MARPOL 72/78" means the International Convention for the Prevention of Pollution from Ships, 1973, as amended by the Protocol of 1978 relating thereto and by any other amendment in force thereafter;
- (d) "noxious liquid substance" means any noxious liquid substance as defined in Annex II of MARPOL 73/78;
- (e) "oil" means petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined oil products (other than petrochemicals which are subject to the provisions of Article 4);
- (f) "oily mixture" means a mixture with any oil content; and
- (g) "ship" means a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms.

Article 2

Application

This Annex applies, with respect to each Party, to ships entitled to fly its flag and to any other ship engaged in or supporting its Antarctic operations, while operating in the Antarctic Treaty area.

Article 3

Discharge of Oil

1 Any discharge into the sea of oil or oily mixture shall be prohibited, except in cases permitted under Annex I of MARPOL 73/78. While operating in the Antarctic Treaty area, ships shall retain on board all sludge, dirty ballast, tank washing waters and other oily residues and mixtures which may not be discharged into the sea. Ships shall discharge these residues only outside the Antarctic Treaty area, at reception facilities or as otherwise permitted under Annex I of MARPOL 73/78.

2 This Article shall not apply to:

(a) the discharge into the sea of oil or oily mixture resulting from damage to a ship or its equipment:

(i) provided that all reasonable precautions have been taken after the occurrence of the damage or discovery of the discharge for the purpose of preventing or minimising the discharge; and

(ii) except if the owner or the Master acted either with intent to cause damage, or recklessly and with the knowledge that damage would probably result; or

(b) the discharge into the sea of substances containing oil which are being used for the purpose of combating specific pollution incidents in order to minimise the damage from pollution.

Article 4

Discharge of Noxious Liquid Substances

The discharge into the sea of any noxious liquid substance, and any other chemical or other substances, in quantities or concentrations that are harmful to the marine environment, shall be prohibited.

Article 5

Disposal of Garbage

1 The disposal into the sea of all plastics, including but not limited to synthetic ropes, synthetic fishing nets, and plastic garbage bags, shall be prohibited.

2 The disposal into the sea of all other garbage, including paper products, rags, glass, metal, bottles, crockery, incineration ash, dunnage, lining and packing materials, shall be prohibited.

3 The disposal into the sea of food wastes may be permitted when they have been passed through a comminuter or grinder, provided that such disposal shall, except in cases permitted under Annex V of MARPOL 73/78, be made as far as practicable from land and ice shelves but in any case not less than 12 nautical miles from the nearest land or ice shelf. Such comminuted or ground food wastes shall be capable of passing through a screen with openings no greater than 25 millimetres.

4 When a substance or material covered by this article is mixed with other such substance or material for discharge or disposal, having different disposal or discharge requirements, the most stringent disposal or discharge requirements shall apply.

5 The provisions of paragraphs 1 and 2 above shall not apply to:

(a) the escape of garbage resulting from damage to a ship or its equipment provided all reasonable precautions have been taken, before and after the occurrence of the damage, for the purpose of preventing or minimising the escape; or

(b) the accidental loss of synthetic fishing nets, provided all reasonable precautions have been taken to prevent such loss.

6 The Parties shall, where appropriate, require the use of garbage record books.

Article 6

Discharge of Sewage

1 Except where it would unduly impair Antarctic operations:

(a) each Party shall eliminate all discharge into the sea of untreated sewage ("sewage" being defined in Annex IV of MARPOL 73/78) within 12 nautical miles of land or ice shelves;

(b) beyond such distance, sewage stored in a holding tank shall not be discharged instantaneously but at a moderate rate and, where practicable, while the ship is en route at a speed of no less than 4 knots.

This paragraph does not apply to ships certified to carry not more than 10 persons.

2 The Parties shall, where appropriate, require the use of sewage record books.

Article 7

Cases of Emergency

1 Articles 3, 4, 5 and 6 of this Annex shall not apply in cases of emergency relating to the safety of a ship and those on board or saving life at sea.

2 Notice of activities undertaken in cases of emergency shall be circulated immediately to all Parties and to the Committee.

Article 8

Effect on Dependent and Associated Ecosystems

In implementing the provisions of this Annex, due consideration shall be given to the need to avoid detrimental effects on dependent and associated ecosystems, outside the Antarctic Treaty area.

Article 9

Ship Retention Capacity and Reception Facilities

1 Each Party shall undertake to ensure that all ships entitled to fly its flag and any other ship engaged in or supporting its Antarctic operations, before entering the Antarctic Treaty area, are fitted with a tank or tanks of sufficient capacity on board for the retention of all sludge, dirty ballast, tank washing water and other oil residues and mixtures, and have sufficient capacity on board for the retention of garbage, while operating in the Antarctic Treaty area and have concluded arrangements to discharge such oily residues and garbage at a reception facility after leaving that area. Ships shall also have sufficient capacity on board for the retention of noxious liquid substances.

2 Each Party at whose ports ships depart en route to or arrive from the Antarctic Treaty area undertakes to ensure that as soon as practicable adequate facilities are provided for the reception of all sludge, dirty ballast, tank washing water, other oily residues and mixtures, and garbage from ships, without causing undue delay, and according to the needs of the ships using them.

3 Parties operating ships which depart to or arrive from the Antarctic Treaty area at ports of other Parties shall consult with those Parties with a view to ensuring that the establishment of port reception facilities does not place an inequitable burden on Parties adjacent to the Antarctic Treaty area.

Article 10

Design, Construction, Manning and Equipment of Ships

In the design, construction, manning and equipment of ships engaged in or supporting Antarctic operations, each Party shall take into account the objectives of this Annex.

Article 11

Sovereign Immunity

1 This Annex shall not apply to any warship, naval auxiliary or other ship owned or operated by a State and used, for the time being, only on government non-commercial service. However, each Party shall ensure by the adoption of appropriate measures not impairing the operations or operational capabilities of such ships owned or operated by it, that such ships act in a manner consistent, so far as is reasonable and practicable, with this Annex.

2 In applying paragraph 1 above, each Party shall take into account the importance of protecting the Antarctic environment.

3 Each Party shall inform the other Parties of how it implements this provision.

4 The dispute settlement procedure set out in Articles 18 to 20 of the Protocol shall not apply to this Article.

Article 12

Preventive Measures and Emergency Preparedness and Response

1 In order to respond more effectively to marine pollution emergencies or the threat thereof in the Antarctic Treaty area, the Parties, in accordance with Article 15 of the Protocol, shall develop contingency plans for marine pollution response in the Antarctic Treaty area, including contingency plans for ships (other than small boats that are part of the operations of fixed sites or of ships) operating in the Antarctic Treaty area, particularly ships carrying oil as cargo, and for oil spills, originating from coastal installations, which enter into the marine environment. To this end they shall:

(a) co-operate in the formulation and implementation of such plans; and

(b) draw on the advice of the Committee, the International Maritime Organisation and other international organisations.

2 The Parties shall also establish procedures for cooperative response to pollution emergencies and shall take appropriate response actions in accordance with such procedures.

Article 13

Review

The Parties shall keep under continuous review the provisions of this Annex and other measures to prevent, reduce and respond to pollution of the Antarctic marine environment, including any amendments and new regulations adopted under MARPOL 73/78, with a view to achieving the objectives of this Annex.

Article 14

Relationship with MARPOL 73/78

With respect to those Parties which are also Parties to MARPOL 73/78, nothing in this Annex shall derogate from the specific rights and obligations thereunder.

Article 15

Amendment or Modification

1 This Annex may be amended or modified by a measure adopted in accordance with Article IX (1) of the Antarctic Treaty. Unless the measure specifies otherwise, the amendment or modification shall be deemed to have been approved, and shall become

effective, one year after the close of the Antarctic Treaty Consultative Meeting at which it was adopted, unless one or more of the Antarctic Treaty Consultative Parties notifies the Depositary, within that time period, that it wishes an extension of that period or that it is unable to approve the measure.

2 Any amendment or modification of this Annex which becomes effective in accordance with paragraph 1 above shall thereafter become effective as to any other Party when notice of approval by it has been received by the Depositary.

Appendix III

Antarctica New Zealand Waste Management Policy

Antarctica New Zealand will minimise, reuse and recycle waste generated by its activities as far as practicable and will ensure that waste is disposed of with minimal environmental impacts. Waste management planning will examine the use, where appropriate, of alternative technologies, materials and disposal options, and identify areas of past activity which require future clean up and/or remediation.

All wastes are to be handled and disposed of in accordance with the following Antarctica New Zealand Waste Management Policy. Practical measures for the implementation of the policy are set out in the Antarctica New Zealand Waste Management Handbook.

1 Treaty Obligations

Antarctic Treaty Recommendation XV-3 sets out agreed practices regarding waste management planning and disposal, and procedures for implementing them. Annex III to the Protocol on Environmental Protection to the Antarctic Treaty (the protocol) provides additional measures for waste management in Antarctica. These measures are legally binding under the Antarctica (Environmental Protection) Act 1994.

2 Waste Management Planning

The **Antarctica New Zealand Environmental Manager** is responsible for developing, implementing and monitoring the Waste Management Policy. Antarctica New Zealand staff and all Antarctic personnel are to be given training in environmental and waste management procedures. At Scott Base, the **Scott Base Manager** has responsibility for implementation of the Waste Management Policy.

3 Prohibited Materials

The protocol prohibits some products from being sent to the Antarctic because of their possible adverse environmental impact. These are:

- poly chlorinated biphenyls (PCBs);
- non-sterile soil;
- polystyrene beads, chips or similar forms of packaging; and
- pesticides (other than those required for scientific, medical or hygiene purposes).

Antarctica New Zealand will make every effort to ensure that none of these substances are sent to Antarctica. The use of poly-vinyl chloride (PVC) products is to be discouraged except where no practicable alternative exists. Similarly, the use of vermiculite will be limited to packaging of hazardous liquids.

4 Waste Minimisation

Antarctica New Zealand aims to minimise the volume of waste produced in Antarctica through practical measures such as strict purchasing procedures for source reduction and reuse of materials wherever possible. Antarctica New Zealand's Environmental Management System sets a target of annually decreasing total waste and increasing the percentage which is recycled, from both Christchurch and Antarctic operations.

5 Wastes Requiring Removal from the Antarctic Treaty Area

The Environmental Protocol specifically lists the following wastes as requiring removal from the Antarctic Treaty area. Antarctica New Zealand will make every effort to ensure that these wastes are returned to New Zealand.

- radioactive materials
- electrical batteries
- fuels, both liquid and solid
- wastes containing harmful levels of heavy metals or acutely toxic or harmful persistent compounds
- poly-vinyl chloride (PVC), polyurethane foam, polystyrene foam, rubber and lubricating oils, treated timbers, and other products incinerated
- all other plastic wastes, except low density polyethylene containers (such as bags for storing wastes), provided such containers shall be incinerated
- fuel drums and other solid, non-combustible wastes provided that the removal of drums and solid, non-combustible waste shall not result in greater adverse environmental impact than leaving them in their existing locations.

6 Waste Separation

Wastes in Antarctica are to be separated into five categories for handling and disposal.

Waste Types

General: Returned to Christchurch for disposal (timber reused where possible)

- non-recyclable paper and card
- uncontaminated plastic
- fabric
- timber
- miscellaneous non-recyclable, non-hazardous items

Recyclables: Returned to New Zealand for recycling

- washed glass
- metal
- washed steel cans
- aluminium cans
- corrugated cardboard
- newsprint paper
- office paper

Hazardous: Returned to New Zealand for appropriate disposal

Chemical:

- oil products
- antifreeze
- batteries
- asbestos
- aerosols
- explosives
- paint products
- detergents, disinfectants and glue
- compressed gas cylinders
- photo chemicals

- mercury
- radioactive wastes
- chemicals

Biohazardous: Returned to New Zealand, sterilised on arrival and sent for appropriate disposal

- food waste
- food contaminated material
- medical waste
- human field waste
- waste water treatment plant by-products
- sanitary waste
- sharps

Domestic liquids: Biologically and UV treated before disposal into the sea. All by-products (screenings and sludge) returned to New Zealand for disposal.

- human solid & liquid waste
- domestic liquid waste
- final rinse photographic water
- hydroponics water

In the Christchurch offices, waste is separated into recyclables (all paper and cardboard, aluminium cans, PET plastics, milk bottles and cartons and glass) and general waste. Any hazardous items are sent for appropriate disposal.

7 Waste Disposal from Antarctica

General Waste

All general waste is to be compacted and returned to New Zealand.

Recyclables

All recyclables are to be returned to New Zealand.

Hazardous Waste

All hazardous wastes are to be returned to New Zealand in appropriately labelled and sealed containment. Biohazardous wastes are to be sterilised on arrival.

Domestic Liquids:

Sewage, domestic liquid waste and final rinse photographic water generated at Scott Base are to be processed in the wastewater treatment plan (screening, biological reduction and UV exposure) and piped directly into the sea.

Disposal of Field Waste

This waste management policy applies to all waste generated in the field. All solid wastes and liquid wastes generated in the field are to be returned to Scott Base. The following wastes are the only exceptions:

- For field parties working on or adjacent to sea ice, sieved grey water and human waste may be disposed of into the sea; and
- When operating from campsites in snow or ice covered areas where transport limitations prevent the practical implementation of this policy, grey water and human waste may be buried in snow-covered glaciers.